DOCUMENT RESUME

ED 240 340 CE 038 250

TITLE	Photovoltaics and Wind Power Systems. Course Syllabus.
INSTITUTION	Bergen County Vocational-Technical High School, Hackensack, N.J.
SPONS AGENCY	New Jersey State Dept. of Education, Trenton. Div. of Vocational Education and Career Preparation.
PUB DATE	Jun 83
NOTE	17p.; For related documents, see CE 038 249-253.
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Air Conditioning; Building Operation; Climate Control; Competence; Conservation Education; Continuing Education; *Course Content; Curriculum; Curriculum Guides; Design Requirements; Electrical Systems; Electric Batteries; Electric Circuits; Electricity; Electronics; Energy Conservation; Heat; Heating; Housing; Job Skills; *Job Training; Maintenance; Mechanics (Process); Postsecondary Education; *Power Technology; Repair; *Solar Energy; Temperature; Trade and Industrial Education; *Wind Energy
IDENTIFIERS	Bergen County Vocational Technical Schools NJ; *Photovoltaic Systems

ABSTRACT

This course is one of four in a solar systems and energy management program developed by the Bergen County Vocational-Technical Schools to help tradespeople (heating, ventilation, and air conditioning mechanics; plumbers; and electricians) to develop an awareness of alternate energy sources and to gain skills in the areas of solar installations and energy evaluation and management. The format of the course is a combination of lectures, visual presentations, and shop sessions. Upon completion of the course, students will be expected to understand the operating principles of photovoltaic and windpower systems, to select a system that is compatible with the proposed energy application, and to perform basic installation and repair procedures for common types of systems. Following introductory materials that explain the purpose and conduct of the course, the course syllabus contains nine units. Each unit consists of an outline, objectives, note to the instructor, and/or shop session notes. The units cover the following topics: introduction and orientation, applied principles of basic electricity, history of windmills, types of windmills, electric storage, wind towers, elements of a feasibility study, introduction to photovoltaics, and photovoltaic system components and assembly. The competencies to be acquired by students are listed at the end of the syllabus. (KC)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED240340

not NCC

BERGEN COUNTY VOCATIONAL-TECHNICAL SCHOOLS
200 Hackensack Avenue
Hackensack, New Jersey 07601

COURSE SYLLABUS

COURSE TITLE:

PHOTOVOLTAICS AND WIND POWER SYSTEMS

CE038250

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

[X] This document has been reproduced as received from the person or organization originating it.
[ ] Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

L Price

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

June, 1983

ENERGY TECHNOLOGY DEPARTMENT

AL BRUNNER, LEAD TEACHER

Trade Extension Division
Bergen County Vocational-Technical Schools
200 Hackensack Avenue
Hackensack, New Jersey 07601

COURSE SYLLABUS

COURSE TITLE: PHOTOVOLTAICS AND WIND POWER SYSTEMS

LENGTH OF COURSE: 36 HOURS

SUGGESTED TEXT:

COURSE DESCRIPTION: This course introduces students to the theory of photovoltaics and windmill systems. Students learn how electricity is transported and stored and the types of systems available on the market, as well as applications and feasibility in a practical environment. Installation, operation and repair procedures are stressed. The class format includes lecture, demonstration and shop projects.

OVERVIEW OF THE ADULT ENERGY TECHNOLOGY PROGRAM

The Energy Technology Program for adults consists of technical training courses offered exclusively by the Bergen County Vocational-Technical Schools and a college-credit certificate program offered in conjunction with Bergen Community College.

Technical training courses offered through this school include Heating, Air Conditioning and Refrigeration, Oil Burner Technician Training, Blueprint Reading and Estimating for the HVAC Trades, Sheet Metal Layout and a new program in Solar Systems and Energy Management. In addition to these part-time technical training programs, the School operates a full-time, intensive training program for HVAC mechanics.

The new solar program is designed for tradespeople (HVAC mechanics, plumbers, electricians) to help them develop an awareness of alternate energy sources such as solar and to gain skills in the areas of solar installations and energy evaluation and management.

INTRODUCTION TO COURSE

The purpose of this course is to provide training to equip students with the technical capability required to install, operate and repair photovoltaic and windmill systems.

Suggested requirements for entrance into this course include successful completion of Introduction to Solar Energy Systems and a basic mechanical aptitude.

The course prepares the student to understand and practice safe system operation, troubleshooting, and basic preventive maintenance. Training is accomplished through class lectures, visual aids, and hands-on experience gained from shop projects.

Upon completion of the course, students will be able to understand the operating principles of photovoltaic and windpower systems, to select a system that is compatible with the proposed energy application, and to perform basic installation and repair procedures for common types of systems.

INSTRUCTIONAL METHODS

A combination of instructional methods will be utilized. Lecture will be supplemented by demonstrations, teacher-prepared handouts and visual aids, including slides, 16mm film and/or overhead projections as may be appropriate to the instructional unit. "Hands-on" shop sessions are designed to reinforce theory, to provide students with job-simulated experiences, and to expose students to equipment utilized in the field.

CLASS REQUIREMENTS

Students will be expected to come prepared for class by completing reading and other homework assignments. Students will be expected to take notes in class and to study in a manner conducive to successful performance on tests and quizzes.

STUDENT EVALUATION AND GRADING

The exact procedure for grading will be the decision of the individual instructor; however, the following guidelines will be adhered to:

1. A written midterm and final examination covering all material presented in the course will be administered and evaluated.
2. An average of six quizzes will be administered and evaluated periodically during the course.
3. Shop/laboratory exercises will be evaluated.
4. Attendance and attitude will be evaluated.
5. Final grade will reflect the aggregated evaluation of the above.

UNIT I: INTRODUCTION AND ORIENTATION

Unit Outline:

A. Overview of the Adult Energy Technology Program
B. Introduction to Course
    1. Description and purpose of course
    2. Pre-requisite requirements
    3. Projected outcomes for students who successfully complete course
        a. Anticipated learning
        b. Job preparation
    4. Class requirements
    5. Instructional methods
    6. Student evaluation and grading policy
C. Safety Regulations (as per district policy)
    1. Proper use of shop equipment
    2. Safety goggles
    3. Clothing
    4. Body mechanics
    5. Emergency procedures in case of accident
D. Fire Information
    1. Fire extinguishers
    2. Fire drills and safe exit from building
E. Smoking Policy
F. General Information for Students
        a. Parking
        b. Book purchase
        c. Breaks
        d. Class cancellation
        e. Certificate of course completion

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Develop an overview of the adult Energy Technology program.

2. Develop a clear understanding of the course, including its purpose, requirements for entrance, projected outcomes, class requirements, methods of instruction, evaluation and grading.

3. Explain and demonstrate safe use of shop equipment.

4. Explain when and why safety goggles are to be utilized.

5. Identify acceptable and unacceptable clothing as related to shop safety.

6. Define the term "body mechanics."

7. Describe the benefits of using good body mechanics in the shop and demonstrate same.

8. Explain the procedure to be followed in case of accident.

9. Identify any combustible materials in the shop and select the proper extinguishing agent(s).

10. Explain the color and letter markings on various fire extinguishers.

11. Demonstrate the proper handling and safety precautions to be used with extinguishers.

12. Demonstrate the fire emergency procedure of the school.

13. Identify the smoking regulations of the school.

14. Review school policy in terms of parking, class breaks, purchase of books, cancellation of class, and certificate requirements upon completion of course.

NOTE TO INSTRUCTOR:

Consult the district Safety Education Program manual (Fall, 1981) for policy and practice relative to general safety regulations, fire information, and smoking policy.

UNIT II: APPLIED PRINCIPLES OF BASIC ELECTRICITY

Unit Outline:

A. Use of common electrical meters
B. Electron Theory
C. Alternating Current (AC)
D. Direct Current (DC)
L. Types of Electrical Conductors
F. Types of Insulators

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Demonstrate proper use of electrical meters such as the voltmeter and ammeter.

2. Explain the role of electron theory in current flow.

3. Define AC and DC and explain applications to energy technology.

4. Identify various types of electrical conductors and insulators and review the criteria used for the selection of specific types.

UNIT III: HISTORY OF WINDMILLS

Unit Outline:

A. Wind-powered grindstones
B. Wind-powered water pumps
C. Wind-powered drainage mills
D. Early wind-powered electric generators

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Identify various types of windmills that have been in use throughout history, and explain their utility.

2. Explain how windmills that appeared in the 1930's and 1940's became forerunners of contemporary designs.

UNIT IV: TYPES OF WINDMILLS

Unit Outline:

A. Horizontal Axis
   1. Single or multi-blade
   2. Upwind or downwind
   3. Farm multi-blade
   4. Multi-rotor
   5. Counter-rotating blades
B. Vertical Axis
   1. Cupped
   2. Turbine
   3. Darrieus
   4. Venturi
C. Equipment
   1. Gear Box/transmission
   2. Hydraulic brakes
   3. Windspeed controllers
   4. Anemometer

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Explain the advantages and disadvantages of the various types of horizontal and vertical axis windmills.

2. Describe the uses of each wind form.

3. Identify a situation where more than one windmill can work together to produce the required energy output.

4. Explain how a anemometer works with a controller and brake to form one complete system.

Shop Session:

Utilizing a kit, students will construct a scaled down, working model of a windmill.

UNIT V: ELECTRIC STORAGE

Unit Outline:

A. Batteries
   1. Lead-acid battery
   2. Jelled electrolyte batteries
   3. Nickel cadmium batteries
   4. Hydrogen rechargeable
   5. Silver zinc or silver cadmium

B. Battery maintenance
   1. Proper discharge
   2. Cycle frequency
   3. Trickle charge
   4. Electrolyte level
   5. Terminal corrosion

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Identify the various types of batteries that can be used for the storage of electricity.

2. Relate the principles of deep cycle, trickle charge, recharge maintenance and cycle frequency, to the various types of batteries.

UNIT VI: WIND TOWERS

Unit Outline:

A. Types
   1. Self-supporting
   2. Guyed supporting
B. Assembly
C. Anchors and foundations
D. Lightening protection

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Identify the two major types of wind towers and describe situations in which each is used.

2. Demonstrate an understanding of safe assembly and construction of a wind tower.

3. Explain why lightening protection is required and how such protection can be achieved.

UNIT VII: ELEMENTS OF A FEASIBILITY STUDY

Unit Outline:

A. Site evaluation
B. Evaluation of energy needs
C. Machine (motor) selection
D. Size calculation (of machine)
E. Selection of other system components
F. Evaluation of system cost
G. Evaluation of system payback

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Identify all of the considerations required for the performance of a feasibility study.

2. Relate elements of a feasibility study to a specific energy application, e.g. a windmill.

Shop Session:

Students will perform a feasibility study for a proposed windmill (or other energy application) at a specific site selected by the instructor.

UNIT VIII: INTRODUCTION TO PHOTOVOLTAICS

Unit Outline:

A. Operational theory
B. Types of photovoltaic cells
    1. Silicon
    2. Selenium
    3. Copper oxide
    4. Gallium arsenide
C. Manufacturing Process
    1. Silicon Crystal
    2. Silicon wafers
    3. Boron vapor process
    4. Trimming
    5. Wire connections

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Identify the various types of photovoltaic (PV) cells and compare them in terms of design, efficiency, and application.

2. Explain how a photovoltaic cell operates and how it acts as a solar collector.

3. Explain how the manufacturing process for photovoltaic cells has evolved, as well as its impact upon the efficiency of the photovoltaic cell as a collector of solar energy.

UNIT IX: PHOTOVOLTAIC SYSTEM COMPONENTS AND ASSEMBLY

Unit Outline:

A. Electrical Connections
   1. Series
   2. Parallel
B. Controllers
   1. Inverters
   2. Utility Interface
C. Concentrating Photovoltaic Arrays
   1. Tracking device
   2. Concentrating lenses
D. Photovoltaic Panel Assembly
   1. Panel location
   2. Panel mounting
   3. Electrical connections
   4. Transparent glazing

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Demonstrate knowledge of the proper electrical connections needed for the wiring of a photovoltaic system.

2. Describe how inverters change direct current (storage) to alternating current (utility) in system operation.

3. Assemble system components into an operating photovoltaic array configuration.

4. Complete a photovoltaic system hook-up by correctly mounting the control panel, performing electrical work and soldering the glass or lexan core.

Shop Sessions:

1. Utilizing a photovoltaic trainer, students will experiment with photovoltaic cells in series or parallel configurations. Students will determine electrical output of the cells through the use of a voltmeter, an ammeter and a load device (motor).

2 & 3. Students will construct a photovoltaic panel, install a model photovoltaic collector and perform the required hook-up to make the system operable.

COURSE PROFICIENCIES

Note: Proficiencies (sometimes referred to as "tasks" or "competencies" in the field of education) are defined as those skills acquired by a student that make he or she employable in a vocational or technical trade. Proficiencies are interpreted to mean applied, practical knowledge, i.e., those skills for which an employer would be willing to pay wages. While unit objectives may reflect learning theory as well as practical skills, the proficiencies refer exclusively to salable skills.

Students who complete this course are expected to achieve the following proficiencies:

1. Work safely in a simulated work environment by consistently demonstrating proper safety measures with regard for themselves, for other people, and for equipment and tools.

2. Determine the correct types of electrical conductors and insulators to use for windpower and photovoltaic energy systems.

3. Select a windmill that is correct for a particular energy requirement based upon an evaluation of both the proposed application and the advantages and disadvantages of the various types of windmills.

4. Perform proper battery maintenance and cycling for the electrical storage component of a windpower system.

5. Evaluate specifications detailed for the construction of a wind tower in terms of safety (anchors, foundations, supports, and lightening protection).

6. Perform a feasibility study for a proposed windpower or photovoltaic system.

7. Select an efficient configuration for a photovoltaic array, construct a PV panel to specifications, install PV collectors, and correctly perform the hook-up needed to render the system operable.